Navy Case No. 83645

MICROSTRIP ANTENNA HAVING MODE SUPPRESSION SLOTS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a microstrip antenna for use on a weapons system to transmit telemetry data from the weapons system. More specifically, the present invention relates to a microstrip antenna which has mode suppression slots and which is adapted for use on a weapons system such as a missile.

2. Description of the Prior Art.

There is currently a need for a microstrip antenna for use in a small diameter projectile and for transmitting telemetry data while suppressing unwanted modes of operation. Normally, microstrip antennas exhibit many modes of operation, that is microstrip antennas will work at multiple frequencies depending upon their construction. A problem occurs when the microstrip antenna is designed to radiate at one mode of operation and not at a frequency band that is outside of the desired mode of operation.

For the desired mode of operation which is 2.250 GHz, the noise radiated by a TM microstrip antenna at the GPS L-1 band (1.575 GHZ) is high enough to raise the effective noise floor to a GPS receiver to substantially reduce the effectiveness of

the GPS receiver.

Thus, there is need to suppress the unwanted noise radiated by the TM microstrip antenna to allow the GPS receiver and its associated antenna to operate effectively at the GPS L-1 band.

SUMMARY OF THE INVENTION

The present invention overcomes some of the difficulties of the past in that comprises a highly effective TM microstrip antenna for suppressing unwanted modes of operation which occur in the GPS L-1 band of 1.575 GHz $\pm$ 10 MHz and substantially reduce noise radiated by the TM microstrip antenna at GPS L-1 band.

The TM microstrip antenna comprising the present invention includes a copper patch, and a dielectric substrate upon which the copper patch is mounted. The TM microstrip antenna also has a pair of elongated slots which are orientated in the direction of surface current flow on the copper patch for the antenna so as not alter the operation of TM microstrip antenna when the antenna is transmitting telemetry data at the TM band. When the antenna is operating GPS L-1 Band the slots reduce current density thereby substantially eliminating noise from a received signal at the GPS L-1 Band and providing increased isolation

from a closely mounted GPS receiving antenna. This allows a GPS microstrip antenna in proximity to the TM microstrip antenna to operate at the GPS L-1 Band since there is adequate isolation between the between the TM microstrip antenna and the GPS receiving antenna.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a preferred embodiment of the present invention which comprises a TM microstrip antenna for use on a weapons system to transmit telemetry data to a receiving station;

FIG. 2 is a side view of the microstrip antenna of FIG. 1;

FIGS. 3 and 4 depict current density on a TM microstrip antenna without slots at various operating frequencies;

FIGS. 5 and 6 depict current density on a TM microstrip antenna with slots at various operating frequencies; and

FIG. 7 depicts isolation between a telemetry antenna and a GPS receiving antenna

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Referring first to FIGS 1 and 2, there is shown a TM microstrip antenna 10 for transmitting telemetry data via an RF

carrier signal to a receiving station. TM microstrip antenna operates in the telemetry band (TM band) at a center frequency of 2.25 GHz. TM microstrip antenna 10 has linear polarization which is achieved by the copper patch/antenna element 12 depicted in FIG. 1. The bandwidth for TM microstrip antenna 10 is ± 10 MHz.

Microstrip antenna 10 includes copper patch/antenna element 12, a dielectric substrate 14 which has the antenna element 12 mounted on its upper surface and a ground plane 15 which is positioned below the dielectric substrate 14 as shown in FIG. 2. The dielectric substrate 14 used in the preferred embodiment of the present invention has a thickness of 0.050 inches and is fabricated from a laminate material RT/Duroid 6002 which is commercially available from Rogers Corporation of Rogers, Connecticut. The dielectric material selected for the microstrip antenna 10 provides sufficient strength and physical and electrical stability to satisfy environmental requirements and is also to mount on or within a missile.

Microstrip antenna's 10 linear polarization is achieved by the rectangular shaped copper patch 12, which has sides/edges 13, 16, 18 and 20 of equal length. The length of each edge 13, and 16 of antenna element 12 is 1.15 inches, and the length of each edge 18 and 20 of antenna element 12 is 0.735 inches

resulting in rectangular shaped antenna element. Dielectric substrate 14 is sized the same as antenna element 12 and also rectangular in shape.

At this time, it should be noted that the dielectric substrate 14 and ground plane 15 extend beyond the antenna element 12 as shown in FIGS. 1 and 2.

Antenna 10 also has two mode suppression slots 22 and 24 which are parallel respectively to edges 18 and 20 of antenna 10. Slot 22 is positioned approximately 0.3558 inches from edge 18 of antenna, while slot 24 is positioned approximately 0.3558 inches from edge 18 of antenna 10. Each slot 22 and 24 has an overall length 0.64 inches and a width 0.020 inches. One end of each slot 22 and 24 is located approximately 0.05 inches from edge 16 of antenna 10. The mode suppression slots 22 and 24 are orientated in the direction of surface current flow on the copper patch 12 for antenna 10 so as not alter the operation of antenna 10 when antenna 10 is transmitting telemetry data at the TM band.

Other modes of operation have currents that cross the mode suppression slots 22 and 24 are impacted by the slots. The slots 22 and 24 result in the frequency of the mode changing so that the frequency moves away from the desired mode's frequency which results in a reduction in interference.

The signal input to antenna 10 is a copper transmission line 26 which has a characteristic impedance of 100 ohms. The copper patch 12 includes a pair of notches 28 and 30 which are positioned on each side of transmission line 28 in proximity to the element feed point 32 for copper patch 12. Notches 28 and 30 are impedance matching notches for the antenna element 12 of TM microstrip antenna 10.

TM microstrip antenna 10 has also eight vias 34, 36, 38, 40, 42, 44, 46 and 48, which are plated through copper holes connecting the antenna element 12 to the ground plane 15. Vias 34, 36, 38, 40, 42, 44, 46 and 48 are positioned approximately 0.05 inches from the edge 16 of antenna 10. The vias 42, 44, 46, and 48 are spaced apart from one another 0.1045 inches with via 48 being positioned 0.1045 inches from edge 20, via 46 being positioned 0.2090 inches from edge 20, via 44 being positioned 0.3135 inches from edge 20, and via 42 being positioned 0.4180 inches from edge 20. The vias 34, 36, 38, and 40 are also spaced apart from one another 0.1045 inches with via 34 being positioned 0.1045 inches from edge 18, via 36 being positioned 0.2090 inches from edge 18, via 38 being positioned 0.3135 inches from edge 18, and via 40 being positioned 0.4180 inches from edge 18.

The vias 34, 36, 38, 40, 42, 44, 46 and 48 short copper

patch 12 to the ground plane allowing TM microstrip antenna 10 to operate as a grounded 1/4 wavelength radiating antenna.

Referring to FIGS. 3 and 4, FIG. 3 depicts current density on a TM microstrip antenna without slots at a frequency of 1.575 GHZ which is the GPS L-1 band and FIG. 4 depicts current density on a TM microstrip antenna without slots at a frequency of 2.25 GHZ which is TM band.

Referring to FIGS. 5 and 6 FIG. 3 depicts current density on a TM microstrip antenna with slots at a frequency of 1.575 GHZ which is the GPS L-1 band and FIG. 6 depicts current density on a TM microstrip antenna with slots at a frequency of 2.25 GHZ which is TM band.

Surface currents are similar in FIGS. 4 and 6 so that the desired mode of operation at 2.25 GHz is not altered and the antenna will produce the same radiation pattern. FIGS. 3 and 5 depict the greatest difference in current densities such that a signal received at 1.575 GHZ will be significantly impacted by the current density produced by antenna 10. As shown in FIG. 6 current density is reduced by the presence of the slots thereby eliminating noise from a received signal at the GPS L-1 Band.

Referring to FIG. 7, the plots of FIG. 7, designated generally by the reference numeral 50, depict a calculated increase in isolation between the TM microstrip antenna

comprising the present invention and GPS receiving antenna located adjacent the TM microstrip antenna. Plot 52 is a computer simulated isolation between the TM microstrip antenna 10 and a GPS receiving antenna while plot 54 is a measured isolation between the TM microstrip antenna 10 and a GPS receiving antenna. Plot 56 is the required isolation between the TM microstrip antenna and the GPS receiving antenna. It should be noted that the plot 54 shows that the required isolation of approximately 50 decibels is achieved at 1.575 GHz and 2.25 GHz.

From the foregoing, it is readily apparent that the present invention comprises a new, unique and exceedingly useful TM microstrip antenna with a slot for transmitting telemetry data which constitutes a considerable improvement over the known prior art. Many modifications and variations of the invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims that the invention may be practiced otherwise than as specifically described.